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(54) A screw propeller boss cap with fins.

(57) A screw propeller boss cap (5) with fins (6) is provided to increase the propeller characteristics, particularly the propeller efficiency. Owing to the fins (6) on the boss cap (5), the water stream rearward of the boss cap (5) is guided to a direction of reducing the generation of the hub vortex and on that score the propeller efficiency is increased. The fins (6) should satisfy the conditions as follows:

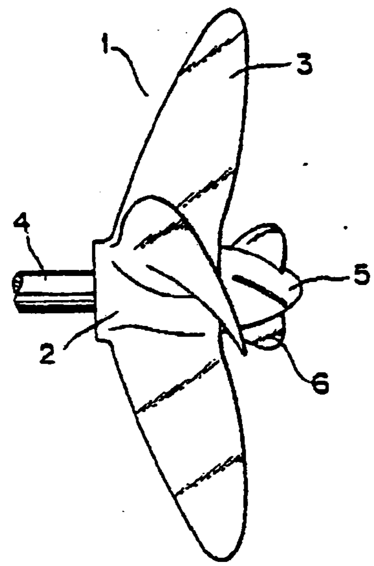
(i) they are of the same number of the propeller blades (3),

(ii) they have an inclination $\alpha$ from -20° to +30° against the geometric pitch angle $\epsilon$ of a propeller blade root, that is, $-20° \leq \alpha - \epsilon \leq 30°$, and the leading edge located between the adjacent propeller blade roots, and

(iii) they have a maximum diameter larger than the diameter of the cap-mounting end of the boss (2) and not larger than 33% of the propeller diameter.

Thus the propeller characteristics can be greatly improved by a rather simple and economically practicable means.

FIG. 2



# A SCREW PROPELLER BOSS CAP WITH FINS

The present invention relates to a boss cap of a screw propeller, particularly to a screw propeller boss cap with fins.

In order to improve the characteristics of a screw propeller, particularly the propeller efficiency, extensive and intensive researches have already been made by engineers with respect to the technical design of number, shape, developed area, pitch, etc. of blades and now their fruits materially have been brought forth to a nearly maximum extent. Thus it is extremely difficult to expect any future drastic improvement of the propeller characteristics through researches on these items.

On the other hand, it has been known that the propeller efficiency of a screw propeller is low in the proximity of its boss. For this reason, it has been proposed for several times to provide a small diameter propeller at the rear stream side of the main propeller so that the propeller efficiency in the proximity of its boss may be raised, for example, in the Japanese Utility Model Laid-opens Nos. 30,195/81 and 139,500/82. It seems however that such idea in fact was not successful, probably for the reason that the thrust does not so much increase as the torque increases and thus the propeller efficiency is not so improved as expected.

An object of the present invention therefore is to provide a new technique which enables to improve the propeller characteristics particularly the propeller efficiency to a considerably high extent through addition of a boss cap with fins to a propeller.

As shown in the attached drawing of Fig. 3 (prior art technique), an ordinary screw propeller 31 comprises a plurality of blades 33 provided in a equidistance around the periphery of a boss 32 and is connected through the boss 32 to a rotational drive shaft 34. On an end opposite to the drive shaft 34 of the boss 32, a conical boss cap 35 is mounted in order to reduce vortices generated downstream of the boss 32 as much as possible.

The present inventors have focused their attention on the fact that even in the rear stream of such propeller boss cap, a considerable hub vortex 36 is generated and, in the thought that the prior art small diameter additional propeller would have increased such hub vortex, have made intensive researches seeking to find any other means for reducing such hub vortex. Finally it has been found that the addition of a boss cap with fins to a propeller can reduce such hub vortex and in effect can increase the propeller efficiency.

Thus the present invention presents a cap to be mounted on a boss of a screw propeller; which cap has fins satisfying the following conditions:

(i) they are of the same number for each propeller blade,

(ii) they have an inclination "Alpha"($\alpha$) from -20° to +30° against the geometric pitch angle "Epsilon"($\epsilon$) of a propeller blade root, that is, -20° ≤ "Alpha" -"Epsilon" ≤ 30°, and the leading edge located between the adjacent propeller blade roots, and

(iii) they have a maximum diameter larger than the diameter of the cap-mounting end of the boss and not larger than 33% of the propeller diameter.

The fins provided according to the present invention are not those for generating a thrust by themselves, but for guiding the water stream rearward of the boss cap to a direction to reduce the generation of the hub vortex.

Owing to such guide effect, the hub vortex in the rearward of the boss cap is diffused and thus the drag force induced by the vortex on a propeller blade plane is reduced and as the result the propeller characteristics particularly the propeller efficiency are greatly improved without remarkable increase of the torque.

Accordingly, as a general tendency, the present invention gives a particularly higher effect to a propeller having a higher pitch ratio (H/D) which generates a stronger hub vortex.

As shown in the embodiments of the present invention hereinafter, the fins may be provided to have a rake angle or a positive or negative camber against the boss cap.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front view of a propeller on which an embodiment of the propeller boss cap with fins of the present invention is mounted, and Fig. 2 is a side view of the Fig. 1.

Fig. 3 is a side view similar to the Fig. 2, but shows a propeller and a boss cap of prior art technique without fins together with a hub vortex generated rearward of the boss cap.

Fig. 4 is a side view partly shown in the section of a propeller characteristics measurement apparatus used in the experiments.

Fig. 5 is a plan view showing plane shape of the fins used in the experiments and Fig. 6 is a side view showing the mounting positions of the fins to the propeller boss cap.

Fig. 7 shows the propeller characteristics curves obtained in the Experiment No. 1 and Figs. 8-10 show the schematic illustrations representative of the relative positions of the propeller blades roots and the fins in the Experiments Nos. 2-4, respectively.

Fig. 11 is a side view to show the rake angle of the fins in the Experiment No. 5 and Fig. 12 is an A-A line sectional view of the Fig. 11.

Fig. 13 is a schematic illustration similar to the Figs. 8-10, but showing the relative positions of the propeller blades roots and the fins in the Experiment No. 6.

Fig. 14 is a diagram showing the results of the Experiment No. 7.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Some embodiments of the present invention will be explained in detail with reference to the attached drawings.

Tests are made in a water tank, using models of propellers having the data as shown in the following table 1. The water tank is of a circular stream type and has an observational part of scales 5.0 m (length) X 2.0 m (width) X 1.0 m (depth). The maximum flow rate is 2.0 m/sec and the uniformity of the flow rate is within 1.5%.

Table 1

| Type | CP24 | CP26 |
|---|---|---|
| Diameter (mm) | 220.0 | 220.0 |
| Pitch ratio | 0.8 | 1.2 |
| Developed blade area ratio | 0.55 | 0.55 |
| Boss ratio | 0.18 | 0.18 |
| Blade thickness ratio | 0.05 | 0.05 |
| Blade cross section shape | MAU | MAU |
| Blade number | 4 | 4 |

In Fig. 4, a side view of a propeller characteristics measurement apparatus is shown partly by a section. This apparatus is located in the observational part of said water tank by securing its propeller open boat 41 to a rigid carrier (not shown) placed above the water tank. The boat 41 has a drive mechanism 43 to rotate a propeller 42 which may detachably be attached to its tip end, a thrust detector 44 and a torque detector 45.

Although not shown in the Fig. 4, a propeller rotating speed is measured by a digital counter TM-225 (product of Ono Measurement Instruments company, Japan) and a flow rate by a combination of a JIS type Pitot tube and a differential pressure converter DLPU-0.02 (product of Toyo Boldwin company, Japan). The analogue signals of such thrust, torque and flow rate represented by the differential pressure, etc. are converted to digital signals through an A/D converter provided in a microprocessor located in a separate controller and processed into physical data which then are printed by a pinter or plotted by a plotter.

A thrust coefficient (KT) and a torque coefficient (KQ) are measured under different advance coefficients (J) adjusted by changing the flow rate while keeping the propeller rotating speed appronprimately constant within the range of 7.5-9.0 r.p.s.. The depth in water of the propeller center is 300 mm and the direction of water flow is as shown by an arrow in the Fig. 4.

As a boss cap to be mounted on the propeller models, a cap of a rounded conical shape having a base diameter of 35 mm and a height of 25.6 mm is prepared. The cap may be mounted on the propeller by any known means and in these experiments a bolt-nut securing is employed.

As fins to be provided on the boss cap, those having six different triangular shapes (A)-(F) shown by a plan view in Fig. 5 are prepared from flat plates of 1 mm thickness to have the dimensions as shown in the following table 2.

Table 2

| Fin shape | Width (X-axis direction) | Height (Y-axis direction) |
|---|---|---|
| (A) | 20 mm | 20 mm |
| (B) | 26 mm | 16.5 mm |
| (C) | 26 mm | 21 mm |
| (D) | 26 mm | 28.5 mm |
| (E) | 26 mm | 34 mm |
| (F) | 26 mm | 39.5 mm |

Fig. 6 shows the relative positions of the fins and the boss cap. In this Fig. 6, a rear end O of a root 62 of a propeller blade 61 is set on the propeller axis 63 as a reference point. In this specification, a peripheral distance from the front end of a fin 64 to the plane including the reference point O and the propeller axis 63 is called "a" (positive in the direction of propeller rotation shown by an arrow). A surface distance from the front end of the fin 64 to a periphery including the reference point O is called "b". The angle of the fin 64 against plane normal to the propeller axis is called "Alpha" ($\alpha$). The geometric pitch angle of the propeller blade root 62 is called "Epsilon"($\epsilon$).

In this specification, the geometric pitch angle $\epsilon$ of a propeller blade root is one based upon a nose-tail line of the propeller blade root. More precisely, two surfaces of a cylindrical surface having an axis on the propeller axis and a radius equal to the boss radius and a propeller blade surface or its extension as a suspected surface are considered. A cylindrical surface intercepted by a crossing line between these two surfaces, that is, a cylindrical section, is developed on a plane. In the developed view, an angle between a nose-tail line of the blade section defined by the developed cylindrical section and a line normal to a generatrix of the cylindrical surface corresponds to the $\epsilon$.

The fin 64 is mounted on the boss cap in the direction perpendicular to the sheet of the Fig. 6, when no rake angle is given. The mounting is made, in these experiments, by cutting a groove on the boss cap, inserting the lower portion of the fin into the groove and fixing by means of an adhesive, but it is of course possible and in actual cases it is preferred to form the boss cap and the fins integrally as one body. The broken lines shown in the lower portions of fins in the Fig. 5 indicate crossing lines between the fin surface and the boss cap surface after mounting of the former on the latter.

Experiment 1

Water tank tests have been made by using the propeller of the type CP26 ($\epsilon$=67.4°) and the fins of Fig. 5(C). The fins of total number 4, one for each propeller blade, are mounted on the boss cap in positions of a=10 mm, b=5 mm and $\alpha$=66°. In this instance, the maximum diameter of the fins, that is, a doubled distance (2r) between the radially remotest end of a fin (from the propeller axis) and the propeller axis (after mounting of the fins on the boss cap) and a propeller diameter (2R) stand in a ratio r/R=0.23. Fig. 1 shows a front view of thus composed propeller 1, boss 2, propeller blades 3, shaft 4, boss cap 5 and fins 6; and Fig. 2 shows a side view thereof. For comparison, tests have been made also as to cases without fins. The thrust coefficient (KT) and the torque coefficient (KQ) have been measured under various advance coefficients (J) of 0.0-1.1 and the propeller efficiency ($\eta$ = J•KT/2PiKQ) has been calculated. Then an increase ratio (d$\eta$) of the propeller efficiency increased from the cases without fins to the cases with fins has been calculated by percents. The results are shown in the following tables 3 and 4.

Table 3 (cases without fins)

| No. | J | KT | KQ x 10 | $\eta$ |
|---|---|---|---|---|
| 0 | 0.000 | 0.4816 | 0.9376 | 0.0000 |
| 1 | 0.050 | 0.4715 | 0.9092 | 0.0413 |
| 2 | 0.100 | 0.4606 | 0.8823 | 0.0831 |
| 3 | 0.150 | 0.4489 | 0.8565 | 0.1251 |
| 4 | 0.200 | 0.4363 | 0.8316 | 0.1670 |
| 5 | 0.250 | 0.4230 | 0.8071 | 0.2085 |
| 6 | 0.300 | 0.4088 | 0.7829 | 0.2493 |
| 7 | 0.350 | 0.3940 | 0.7586 | 0.2893 |
| 8 | 0.400 | 0.3785 | 0.7342 | 0.3282 |
| 9 | 0.450 | 0.3623 | 0.7094 | 0.3657 |
| 10 | 0.500 | 0.3454 | 0.6839 | 0.4019 |
| 11 | 0.550 | 0.3281 | 0.6578 | 0.4365 |
| 12 | 0.600 | 0.3102 | 0.6309 | 0.4695 |
| 13 | 0.650 | 0.2919 | 0.6031 | 0.5007 |
| 14 | 0.700 | 0.2731 | 0.5743 | 0.5299 |
| 15 | 0.750 | 0.2541 | 0.5445 | 0.5571 |
| 16 | 0.800 | 0.2349 | 0.5138 | 0.5820 |
| 17 | 0.850 | 0.2154 | 0.4820 | 0.6046 |
| 18 | 0.900 | 0.1959 | 0.4494 | 0.6244 |
| 19 | 0.950 | 0.1764 | 0.4159 | 0.6413 |
| 20 | 1.000 | 0.1570 | 0.3817 | 0.6547 |
| 21 | 1.050 | 0.1378 | 0.3468 | 0.6639 |
| 22 | 1.100 | 0.1189 | 0.3115 | 0.6680 |

Table 4 (cases with fins)

| No. | J | KT | KQ x 10 | $\eta$ | $d\eta$ (%) |
|---|---|---|---|---|---|
| 0 | 0.000 | 0.4985 | 0.9154 | 0.0000 | |
| 1 | 0.050 | 0.4894 | 0.8914 | 0.0437 | 5.55 |
| 2 | 0.100 | 0.4785 | 0.8677 | 0.0878 | 5.35 |
| 3 | 0.150 | 0.4660 | 0.8440 | 0.1318 | 5.09 |
| 4 | 0.200 | 0.4522 | 0.8204 | 0.1755 | 4.81 |
| 5 | 0.250 | 0.4373 | 0.7965 | 0.2184 | 4.54 |
| 6 | 0.300 | 0.4215 | 0.7724 | 0.2605 | 4.29 |
| 7 | 0.350 | 0.4050 | 0.7479 | 0.3016 | 4.09 |
| 8 | 0.400 | 0.3880 | 0.7229 | 0.3417 | 3.96 |
| 9 | 0.450 | 0.3705 | 0.6973 | 0.3806 | 3.90 |
| 10 | 0.500 | 0.3528 | 0.6710 | 0.4184 | 3.95 |
| 11 | 0.550 | 0.3349 | 0.6441 | 0.4552 | 4.09 |
| 12 | 0.600 | 0.3168 | 0.6164 | 0.4909 | 4.35 |
| 13 | 0.650 | 0.2986 | 0.5879 | 0.5255 | 4.73 |
| 14 | 0.700 | 0.2803 | 0.5585 | 0.5590 | 5.21 |
| 15 | 0.750 | 0.2617 | 0.5284 | 0.5913 | 5.78 |
| 16 | 0.800 | 0.2430 | 0.4974 | 0.6220 | 6.42 |
| 17 | 0.850 | 0.2239 | 0.4655 | 0.6506 | 7.07 |
| 18 | 0.900 | 0.2044 | 0.4328 | 0.6762 | 7.66 |
| 19 | 0.950 | 0.1843 | 0.3994 | 0.6976 | 8.07 |
| 20 | 1.000 | 0.1634 | 0.3652 | 0.7123 | 8.09 |
| 21 | 1.050 | 0.1417 | 0.3303 | 0.7168 | 7.38 |
| 22 | 1.100 | 0.1187 | 0.2947 | 0.7053 | 5.29 |

Fig. 7 illustrates the results of the tables 3 and 4 showing the advance coefficient (J) in abscissa and the thrust coefficient (KT), the torque coefficient multiplied by ten (KQ x 10) and the propeller efficiency ($\eta$) in ordinate. In this Fig. 7, curves T2, Q2 and P2 represents KT, KQ x 10 and $\eta$ in the table 3 and curves T3, Q3 and P3 represents KT, KQ x 10 and d$\eta$ in the table 4. From this Fig. 7 and the table 4, it is understood that the propeller efficiency increases about 4-8% in the overall range of J = 0.05-1.10 and particularly 7.66% at the usually employed J = 0.9.

Further, in these tests, a needle pipe is manually put into the water from above the water tank to the close proximity of the rear end of the boss cap to supply air bubbles. It has been found that in the cases without fins, a large number of air bubbles align along the propeller axis, but in the cases with fins, air bubbles are diffused to disappear. It is considered that a hub vortex is greatly reduced by the merit of the fins.

## Experiment 2

Tests similar to those shown in the Experiment 1 have been made, but using different positions of fins, that is, different a, b and $\alpha$. The propeller efficiency increase ratio obtained under the usually employed advance coefficient (J) = 0.9 is shown in the following table 5.

### Table 5

| No. | a (mm) | b (mm) | $\alpha$ (°) | $\alpha - \epsilon$ (°) | r/R | d$\eta$ (%) |
|---|---|---|---|---|---|---|
| 1 | 10 | 0 | 64 | -3.4 | 0.25 | 5.49 |
| 2 | 15 | 0 | 61 | -6.4 | 0.25 | 7.32 |
| 3* | 10 | 5 | 66 | -1.4 | 0.23 | 7.66 |
| 4 | 14 | 5 | 59 | -8.4 | 0.23 | 6.39 |

* . . . from the data in the Experiment 1

The relative positions of fins and the propeller blade roots are illustrated in Fig. 8, wherein the rear end O of one propeller blade root shown in the Fig. 6 is placed on the base line X, and the blade position is shown as a line segment starting from the base line X with an angle $\epsilon$ and having a length corresponding to the length of the nose-tail line of the propeller blade root. Another propeller blade root adjacent to said one also is shown is a similar manner, but at a peripheral distance between the rear ends of them taken in the direction of the base line X. The positions of the fins are shown by taking "a" of the Fig. 6 in the direction of the base line X and "b" of the Fig. 6 in the direction of a base line Y which passes through the reference point O normally to the base line X. The lengths of the fin segments correspond to the lengths of the crossing lines between the fins and the boss cap as shown in the Fig. 5 by broken lines. From the table 5 and the Fig. 8, it is understood that a considerable improvement of propeller efficiency can be obtained when the front ends of fins are placed between the adjacent propeller blade roots, that is, within a space between extended nose-tail lines of the adjacent propeller blade roots.

Experiment 3

Tests similar to those of Experiment 1 have been made, but changing only $\alpha$. The propeller efficiency increase ratio obtained at the advance coefficient (J) = 0.9 is shown in the following table 6.

Table 6

| No. | $\alpha$ (°) | $\alpha-\epsilon$ (°) | r/R | $d\eta$ (%) |
|---|---|---|---|---|
| 1 | 45 | -22.4 | 0.24 | 0.34 |
| 2 | 50 | -17.4 | 0.235 | 3.46 |
| 3* | 66 | - 1.4 | 0.23 | 7.66 |
| 4 | 85 | 17.6 | 0.22 | 3.80 |
| 5 | 90 | 22.6 | 0.22 | 2.19 |
| 6 | 95 | 27.6 | 0.22 | 2.38 |
| 7 | 100 | 32.6 | 0.22 | 0.77 |
| 8 | 105 | 37.6 | 0.22 | 0.47 |

* . . . from the data of Experiment 1

The results of the table 6 are shown in Fig. 9 similarly to the Experiment 2. It is understood from the table 6 and the Fig. 9 that a considerable improvement of propeller efficiency can be obtained within the range of $-20° \leq \alpha-\epsilon \leq 30°$.

Experiment 4

Tests similar to those of Experiment 2 have been made, but using the propeller of the type CP24 ($\epsilon$ = 57.4°) and the fins of the Fig. 5(A) and 5(C). The propeller efficiency increase ratio obtained at the advance coefficient (J) = 0.6 usually employed for such propeller is shown in the following table 7.

Table 7

| No. | a (mm) | b (mm) | $\alpha$ (°) | $\alpha-\epsilon$ (°) | r/R | Fin shape | $d\eta$ (%) |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 5 | 80 | 22.6 | 0.21 | (A) | 2.03 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | 10 | 17 | 63 | 5.6 | 0.18 | (A) | 3.02 |
| 3 | 5 | 12 | 63 | 5.6 | 0.20 | (A) | 2.06 |
| 4 | 5 | 9.5 | 63 | 5.6 | 0.21 | (A) | 2.32 |
| 5 | 5 | 7 | 63 | 5.6 | 0.215 | (A) | 2.84 |
| 6 | 10 | 7 | 63 | 5.6 | 0.23 | (C) | 3.93 |
| 7 | 10 | 7 | 57 | -0.4 | 0.22 | (C) | 2.32 |
| 8 | 6 | 7 | 63 | 5.6 | 0.22 | (C) | 2.57 |
| 9 | 4 | 5 | 35 | -22.4 | 0.235 | (C) | -0.09 |
| 10 | 4 | 5 | 90 | 32.6 | 0.22 | (C) | -0.19 |

The results of the table 7 are shown in Fig. 10 similarly to Experiment 2. It is understood that there is no material difference between the fin shapes (A) and (C) and that the fin positions should satisfy the conditions that the front end of the fin is located between the adjacent propeller blade roots and the inclination of the fin stands within the range of $-20° \leq \alpha - \varepsilon \leq 30°$, as in the case of said Fig. 9.

Experiment 5

The test of Experiment 4, No. 6 has been repeated, adding rake angles of ±30° to the fins. The rake angles are measured from the direction perpendicular to the sheet of the Fig. 6 to the direction of rotation of the propeller. The results are shown in the following table 8.

Table 8

| No. | a (mm) | b (mm) | $\alpha$ (°) | $\alpha - \varepsilon$ (°) | r/R | Rake Angle (°) | $d\eta$ (%) |
|---|---|---|---|---|---|---|---|
| 6F | 10 | 7 | 63 | 5.6 | 0.21 | +30 | 1.46 |
| 6M* | 10 | 7 | 63 | 5.6 | 0.23 | 0 | 3.93 |
| 6B | 10 | 7 | 63 | 5.6 | 0.21 | -30 | 4.47 |

* . . . from the data of Experiment 4

From the table 8, it is understood that there is a tendency of further improvement of $d\eta$ when a rake angle opposite to the rotation direction of the propeller is added to fins. The mounting positions of fins are shown in Fig. 11 by way of a side view similar to the Fig. 6 and in Fig. 12 which is an A-A line section of the Fig. 11.

Experiment 6

The tests of Experiment 4, No. 7 has been repeated, but by changing the number and positions of the fins. the results are shown in the following table 9.

Table 9

| No. | a (mm) | b (mm) | $\alpha$ (°) | $\alpha - \epsilon$ (°) | r/R | Fin Number | $d\eta$ (%) |
|---|---|---|---|---|---|---|---|
| 7-N2 | 10** | 7 | 57 | -0.4 | 0.22 | 2 | -0.12 |
| 7-N3 | 10** | 7 | 57 | -0.4 | 0.22 | 3 | 0.49 |
| 7-N4* | 10 | 7 | 57 | -0.4 | 0.22 | 4 | 2.32 |
| 7-N5 | 10** | 7 | 57 | -0.4 | 0.22 | 5 | -1.12 |

* . . . from the data of Experiment 4

** . . . value of one specific fin; values of the other fins correspond to the positions determined by the quotient of 360° divided by the number of fins

The relative positions of the propeller blade roots and the fins are shown in Fig. 13 by way of X-Y plane as in the Figs. 8-10. Relative to the four propeller blade roots B1-B4, the fins are located, in the case of fin number two, at the positions 1/F and 2/2; in the case of fin number three, at the positions 1/F, 2/3 and 3/3; in the case of fin number four, at the positions 1/F, 2/4, 3/4 and 4/4; and in the case of fin number five, at the positions 1/F, 2/5, 3/5, 4/5 and 5/5, as shown in the Fig. 13. It can be seen therefrom that there is no fin located, in the case of fin number two, between the propeller blade roots B2 and B3 and between B4 and B1; in the case of fin number three, between B3 and B4. Further, there are two fins between B3 and B4 in the case of fin number five. Thus the fins are not evenly positioned in the cases of fin number two, three and five.

It is understood from the table 8 that the number of fins should be same for each space between the adjacent propeller blade roots.

Experiment 7

Tests similar to those of Experiment 1 have been made, but by using various fins of the Fig. 5(B)-5(F) having the same width but different heights. Total four same shape fins, one for each propeller blade, are mounted in the positions determined by a = 10 mm, b = 5 mm and $\alpha$ = 66°. The propeller efficiency increase ratio obtained at the advance coefficient (J) = 0.9 is shown in the following table 10.

Table 10

| No. | a (mm) | b (mm) | $\alpha$ (°) | $\alpha-\varepsilon$ (°) | r/R | Fin shape | $d\eta$ (%) |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 5 | 66 | -1.4 | 0.2 | (B) | 4.12 |
| 2* | 10 | 5 | 66 | -1.4 | 0.23 | (C) | 7.66 |
| 3 | 10 | 5 | 66 | -1.4 | 0.3 | (D) | 6.08 |
| 4 | 10 | 5 | 66 | -1.4 | 0.35 | (E) | 0.87 |
| 5 | 10 | 5 | 66 | -1.4 | 0.4 | (F) | -0.50 |

* . . . from the data of Experiment 1

The results of the table 10 are illustrated in Fig. 14, taking r/R in abscissa and $d\eta$ in ordinate.

In view of the fact that the boss ratio of the propeller of type CP26 is 0.18, it is unerstood that the maximum diameter of the fins should be greater than the diameter of the cap-mounting end of the boss and not be greater than 33% of the propeller diameter, in order to obtain a considerable improvement of the propeller efficiency.

Experiment 8

Tests similar to those of Experiment 1 have been made, but by using fins of the Fig. 5(C) bended to an arc of radius 50 mm. Two kinds of fins, one bended to the arc convex in the direction of propeller rotation (= C-out) and the other to the arc concave in the direction of propeller rotation (= C-in), are used. Total four same shape fins, one for each propeller blade, are mounted in the positions determined by a = 10 mm, b = 5 mm and $\alpha$ = 66° (= angle of the direction of the chord of the arc). The propeller efficiency increase ratio as obtained at the advance coefficient (J) = 0.9 is shown in the following table II.

Table 11

| No. | a (mm) | b (mm) | $\alpha$ (°) | $\alpha-\varepsilon$ (°) | r/R | Fin shape | $d\eta$ (%) |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 5 | 66 | -1.4 | 0.23 | C-out | 6.46 |
| 2* | 10 | 5 | 66 | -1.4 | 0.23 | C | 7.66 |
| 3 | 10 | 5 | 66 | -1.4 | 0.23 | C-in | 6.94 |

* . . . from the data of Experiment 1

From the above data, it is understood that the shape of fins is not limited to plane and may have a positive or a negative camber.

As explained in detail above, it is possible to improve the propeller characteristics particularly the propeller efficiency without increasing torque, by the effect of guiding the water stream rearward of the boss cap to a direction of reducing generation of hub vortex, through the provision of fins on a boss cap to be mounted on a screw propeller in accordance with the present invention.

According to such invention, further merits are obtained, for example, the propeller characteristics may greatly be improved only by a slight modification of a rather small boss cap and not by a drastic change of the screw propeller itself, to which the boss cap is appended, necessitating difficult work and high cost. In effect, the present invention is applicable to screw propellers already mounted on existing ships, simply by exchanging or working the boss cap without incurring high cost.

## Claims

1. A cap to be mounted on a boss of a screw propeller; which cap has fins satisfying the following conditions:

(i) they are of the same number for each propeller blade,

(ii) they have an inclination $\alpha$ from -20° to +30° against the geometric pitch angle $\epsilon$ of a propeller blade root, that is, $-20° \leqq \alpha - \epsilon \leqq 30°$, and the leading edge located between the adjacent propeller blade roots, and

(iii) they have a maximum diameter larger than the diameter of the cap-mounting end of the boss and not larger than 33% of the propeller diameter.

FIG. 1

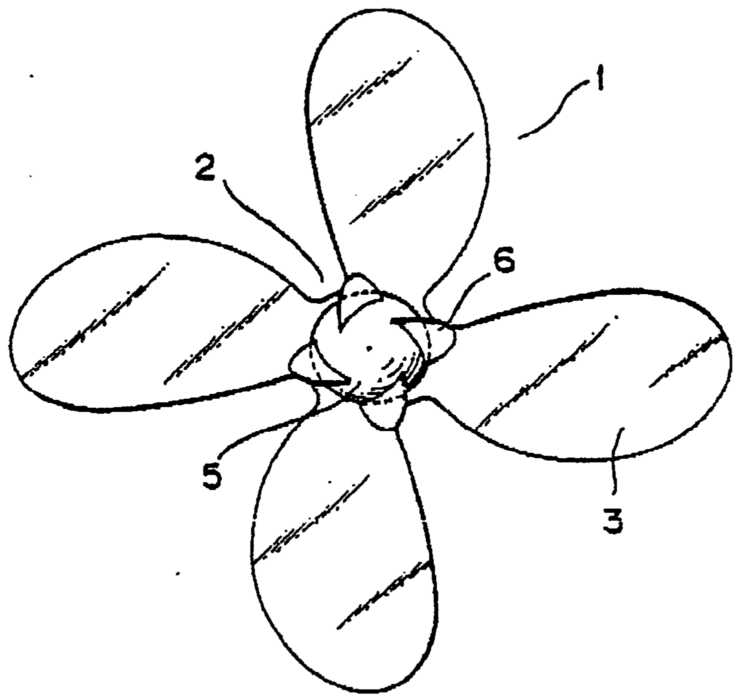


FIG. 2

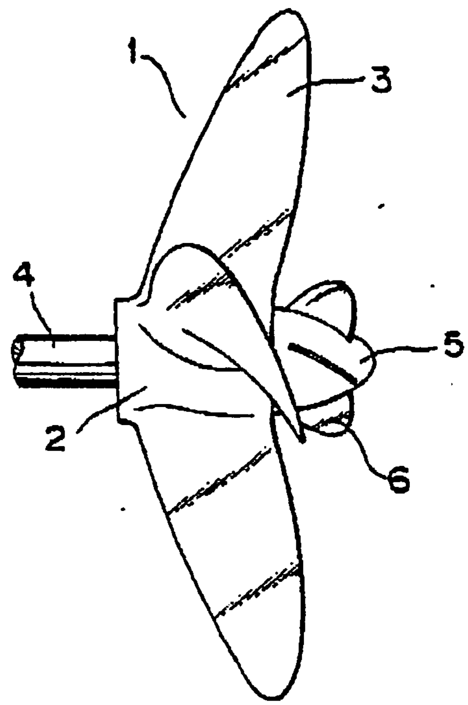



FIG. 3 Prior Art Technique

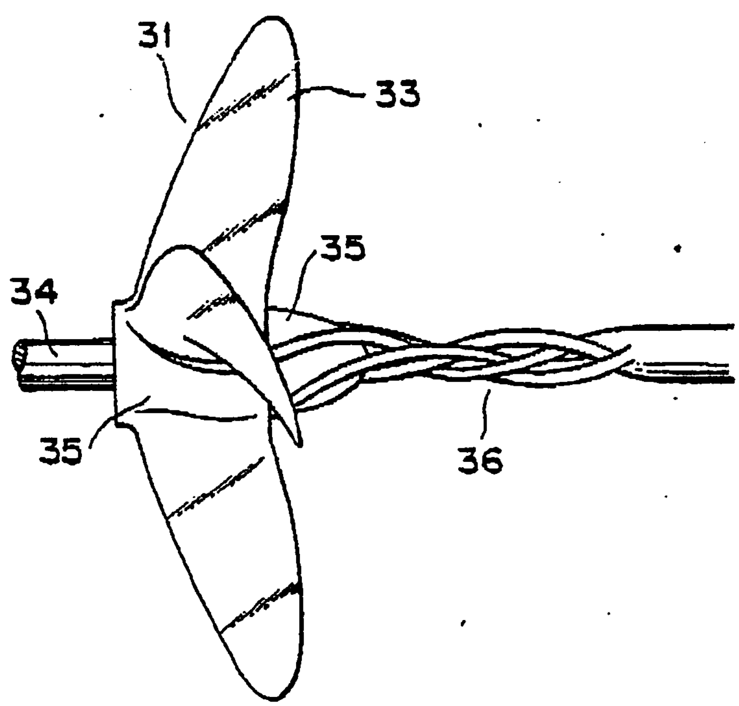


FIG. 4

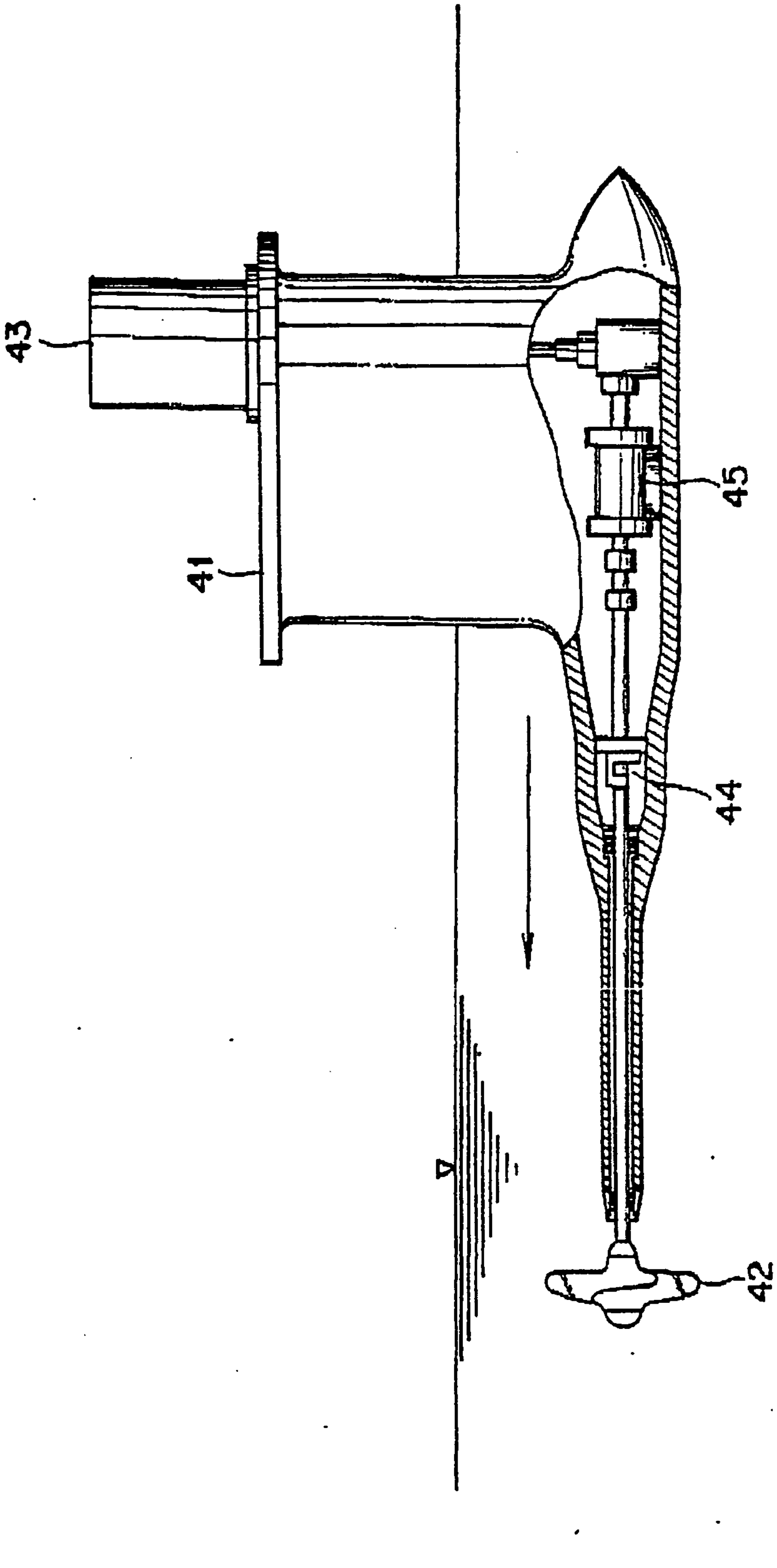


FIG. 5

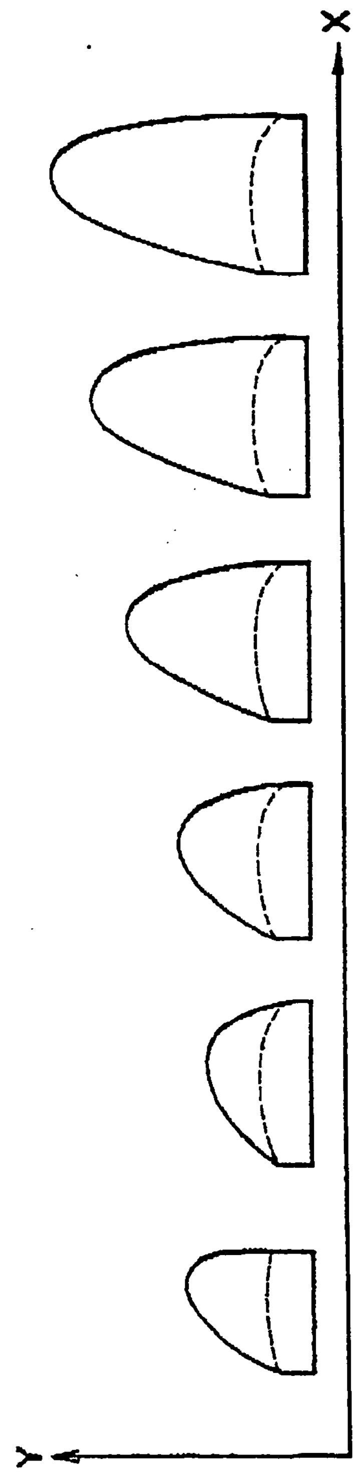



FIG. 6

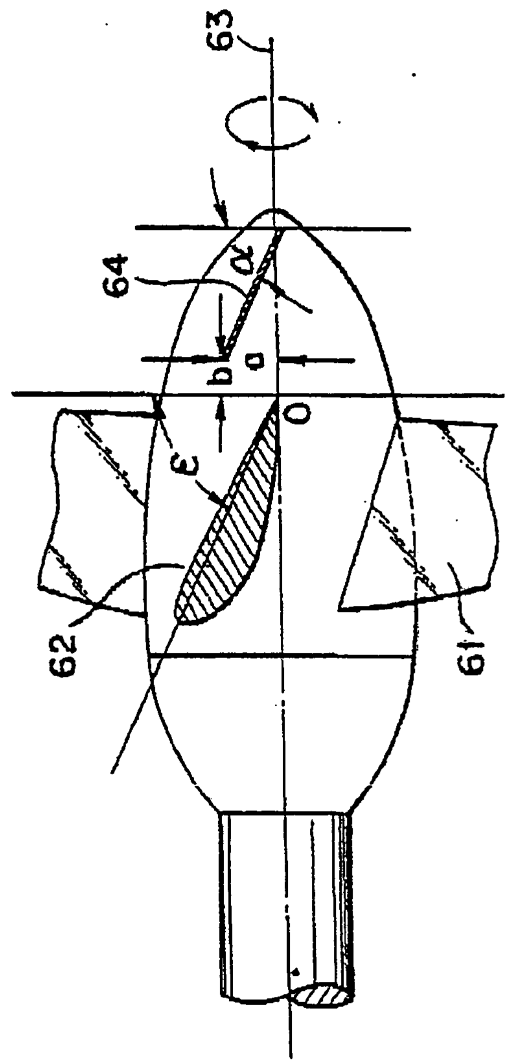


FIG. 7

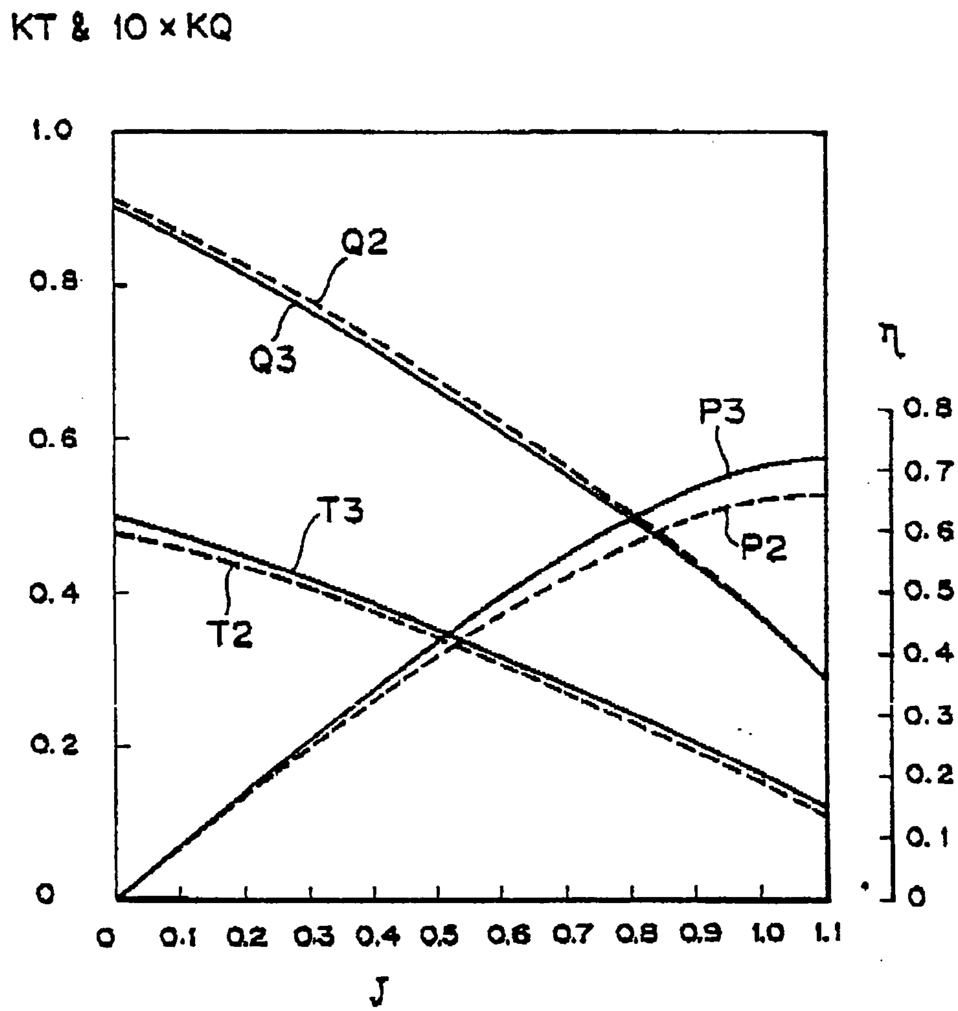

KT & 10 × KQ
1.0
0.8
0.6
0.4
0.2
0
Q2
Q3
P3
P2
T3
T2
η
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
J

FIG. 8

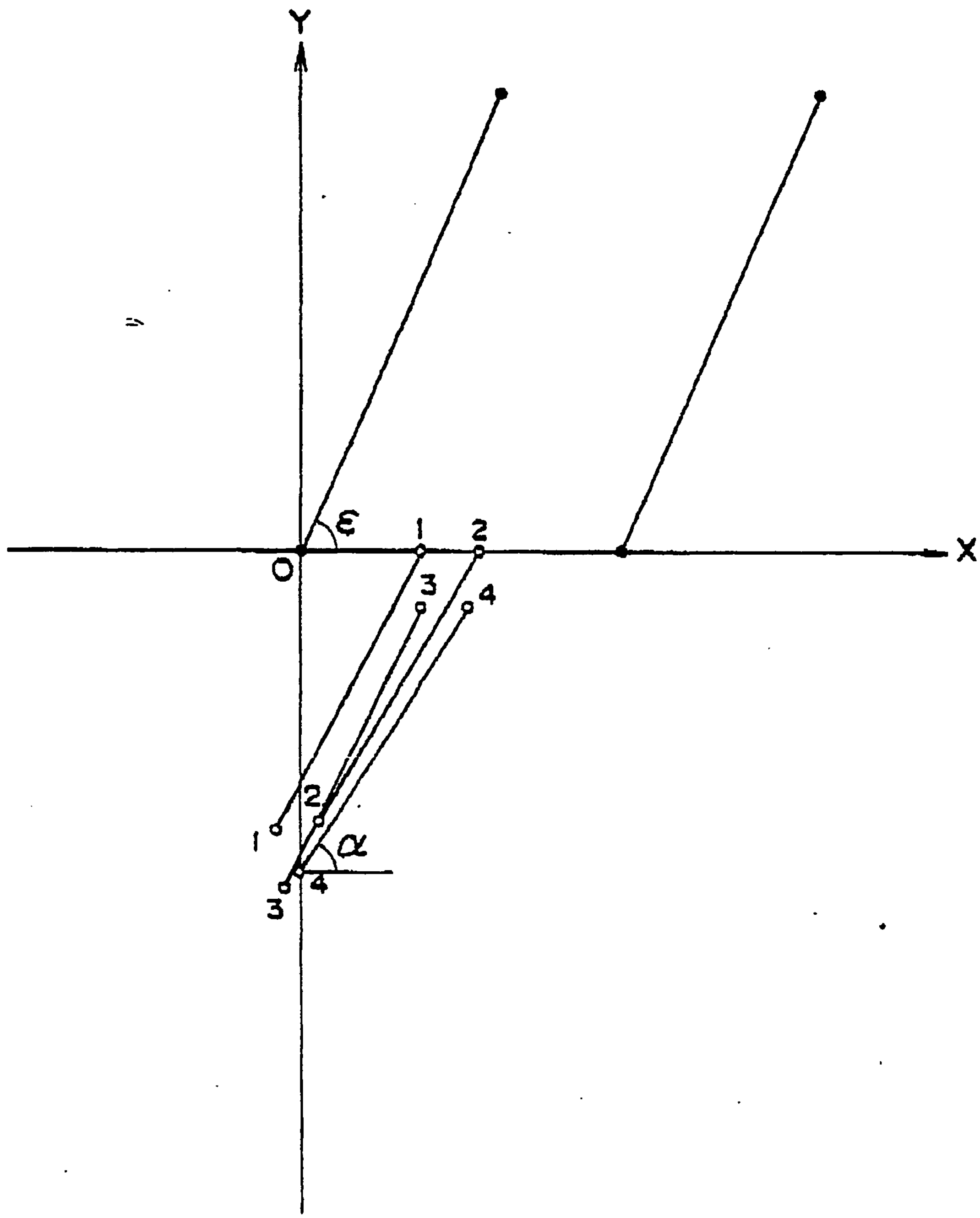


FIG. 9

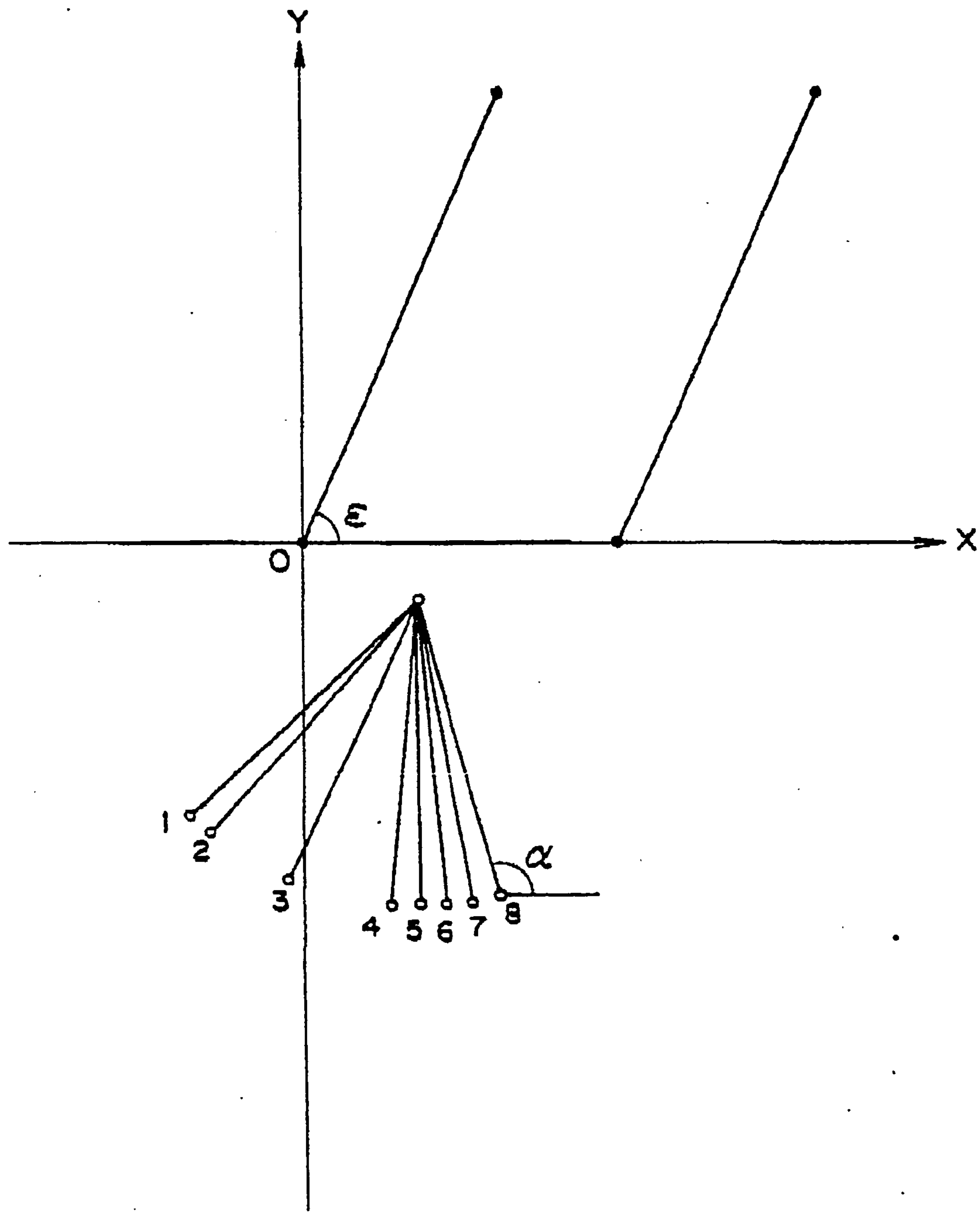


FIG. 10

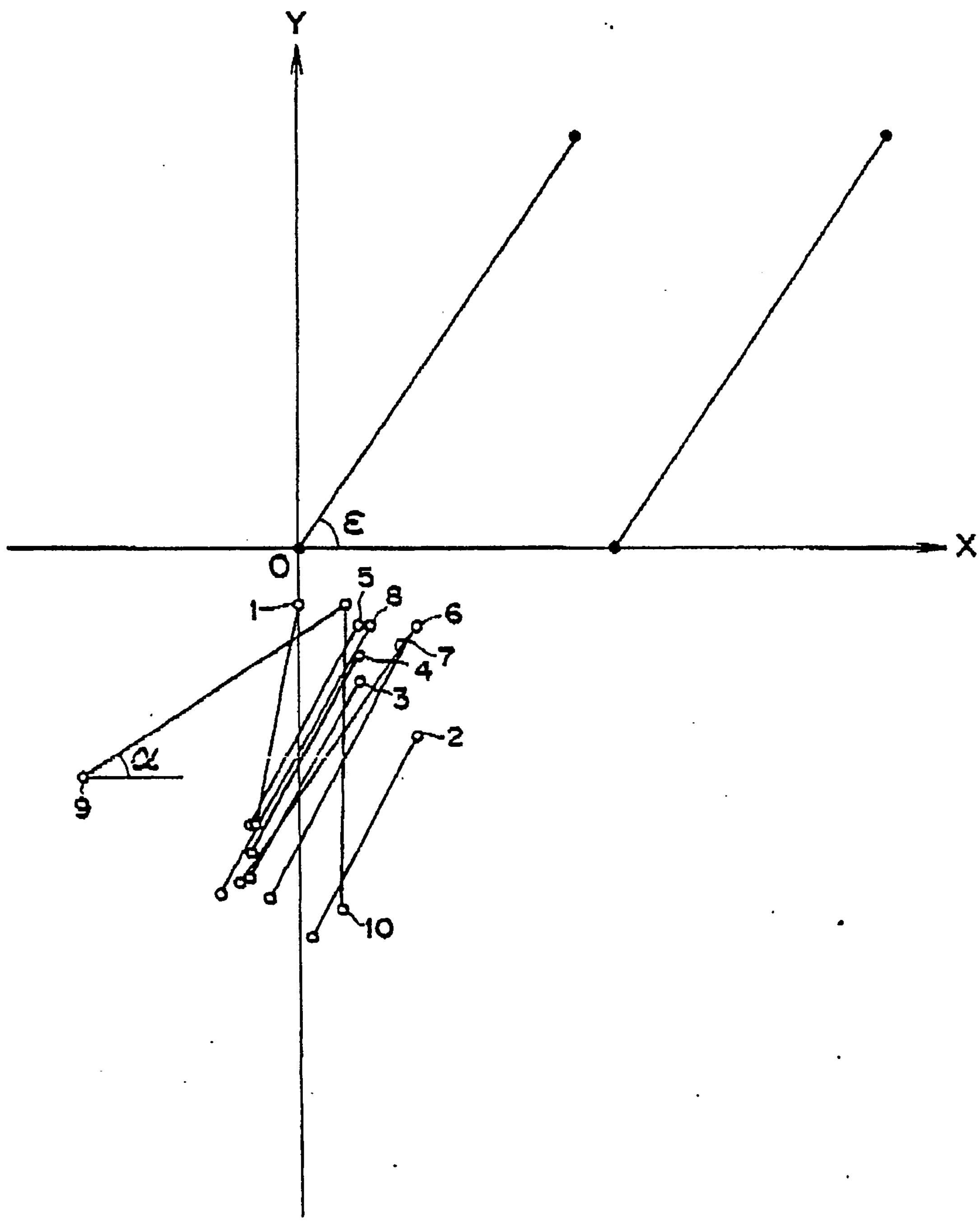


FIG. 11

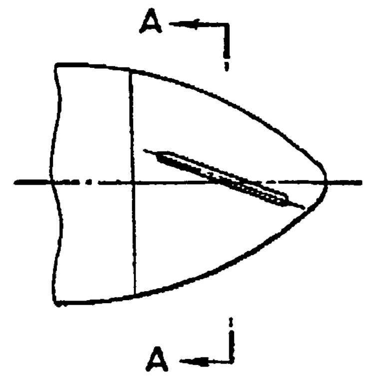



FIG. 12

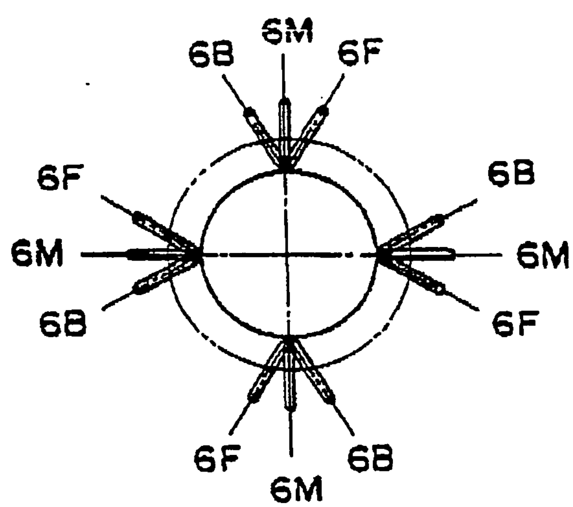


FIG. 13

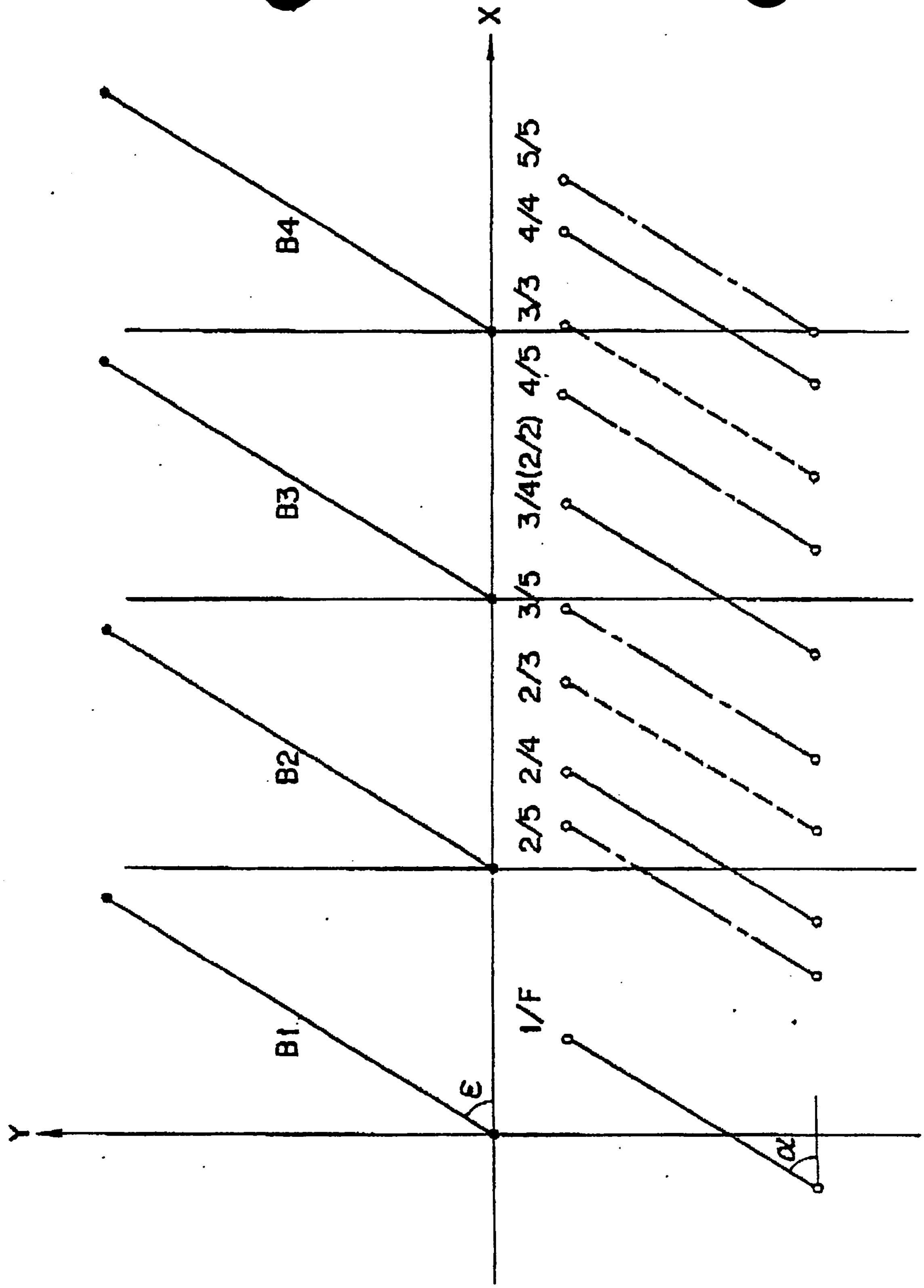
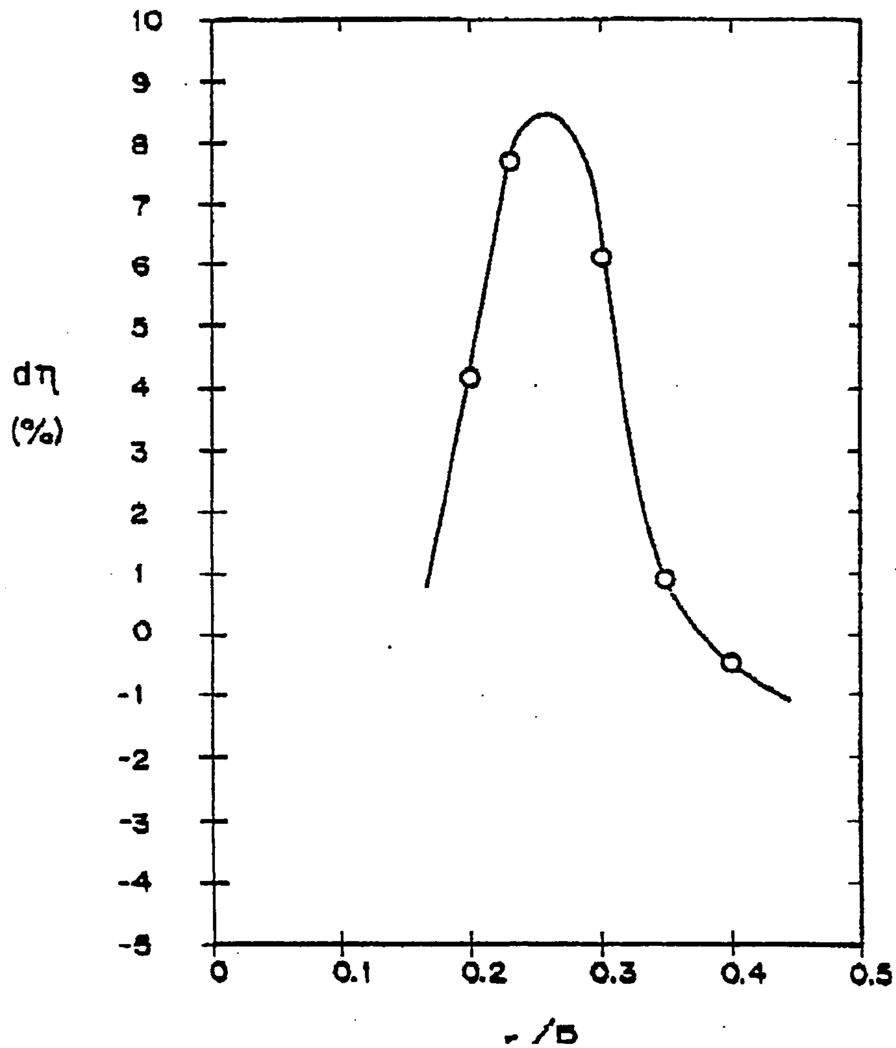


FIG. 14



European Patent Office

# EUROPEAN SEARCH REPORT

Application number

EP 87 11 1052

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.4) |
|---|---|---|---|
| A | US-A-3 606 579 (H. MEHUS)<br>* Abstract; figures *<br>--- | 1 | B 63 H 1/28 |
| A | DE-A-3 037 369 (W. WÜHRER)<br>* Page 1, lines 1-10; figure 1 *<br>--- | 1 | |
| A | US-A-2 755 868 (C. SMITH)<br>* Column 4, lines 74,75; column 5, lines 1-26; figure 1 *<br>--- | 1 | |
| A | GB-A- 652 441 (E. SHELLBERG)<br>* Page 1, lines 21-33; figures 5,6 *<br>----- | 1 | |
| | | | **TECHNICAL FIELDS SEARCHED (Int. Cl.4)** |
| | | | B 63 H<br>B 64 C |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 06-11-1987 | VISENTIN, M. |

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